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MEMORANDUM

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TO: File
FROM: Irving L. Soffer
DATE: February 10, 1966
SUBJECT: DEMONSTRATION OF STAINLESS STEEL EXTERIOR WALL MOCK-UP BY THE REPUBLIC STEEL COMPANY IN YOUNGSTOWN, OHIO

REFERENCE:

COPY TO: J. Kyle, E. Mills, R. Monti, H. Roberts, R. Sullivan, H. Tessler, G. Tozzoli; I. Gershon (ERS), H. Harman (ERS), L. Robertson (WSHJ), A. Schreier (MYA)

On January 27, 1966 we attended a demonstration of a stainless steel exterior wall mock-up of The World Trade Center towers by the Republic Steel Manufacturing Division in Youngstown, Ohio.

The following persons were present:

M. P. Levy, WTC Planning & Construction Division
H. A. Tessler, WTC Planning & Construction Division
I. L. Soffer, WTC Planning & Construction Division
I. Gershon, Emery Roth & Sons
M. Wolff, Emery Roth & Sons
A. Schreier, Minoru Yamasaki & Associates
H. Tshuchiya, Minoru Yamasaki & Associates
J. Kirtwood, General Manager, Republic Steel Manufacturing Company and various members of his staff
W. Cody, Sales Engineer, Republic Steel Company, New York
C. Bruno, District Manager, Republic Steel Company, New York

The demonstration was in two parts. The first was an exterior wall mock-up, 11 feet wide and 28 feet high, built outdoors. This included four exterior columns and over two floors high.

Attached are photographs of the exterior wall mock-up.

The exterior wall elements contain the following:

1. The two left column cover materials were Republic stainless steel - Enduro - Ezy Blend - Dull - 18 gauge material.

2. The two right column cover materials were Republic stainless steel - Enduro - 2-B-N (modified for WTC) - 18 gauge material.

3. Window washing track material - stainless steel - Finish #7 - AISI standard.

4. Spandrel covers - porcelainized on enameling iron (carbon steel material).

5. Glazing - Solar Bronze Glass - ¼" thick.

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6. Left outside column - fireproofed with column cover in place and the fireproofing material pumped down (12 foot lifts) into void between the inside of the column cover and the outside of box steel exterior column. This material was "Zonolite", a lightweight vermiculite concrete fill, as produced by the W. R. Grace Company.

7. Right outside column - fireproofed by spraying the exterior box column with a cementitious material - U. S. Gypsum Company - Fire Code V vermiculite-gypsum. This material was sprayed on the box column prior to installing the exterior column cover. The columns require a four hour protection and the spandrels a three hour rating.

The above materials were proposed by Republic Steel Company to show typical recommendations in their development of the exterior wall; as shown on basic design criteria Drawing A-A-303 by ERS.

The second part of the demonstration was held in Republic's Research & Development Center; for a WTC simulated environmental test. A similar exterior facing mock-up of the wall was built in their pressure chamber, which was approximately ten feet wide and 20 feet high. The assembled test sample consisted of the column covers, spandrel covers, glass and all the joint seals between these elements. A pressurized water spray is blown against the exterior face of the wall and observation is made of the interior to examine for trace of leaks.

The pressures to be tested are as follows:

VELOCITY WIND M.P.H.	PRESSURE VELOCITY LBS./SQ. FT.	EQUIVALENT HEAD INCHES OF WATER
5	.0623	.012
10	.2493	.048
15 (1)	.5608	.108
20	.9971	.192
25	1.5579	.300
30	2.2434	.432
35 (2)	3.0535	.588
40	3.9883	.768
45	5.0476	.972
50 (3)	6.2317	1.200
55	7.5408	1.452
60	8.9737	1.728
65 (4)	10.5316	2.028
70	12.2142	2.352
75 (5)	14.0214	2.700
80	15.9532	3.072
85	18.0097	3.468
90	20.1908	3.888
95	22.4965	4.332
100 (6)	24.9269	4.800
150	56.0855	10.800

(1) Moderate breeze

(3) Strong gale
(4) Storm
(5) Hurricane
(6) Uproots trees, etc.

Pressure shown is simple velocity pressure, not corrected for gusts or shape, but corrected to 68° F. This table is developed from the Emswiler Formula.

The pressurized water spray had been underway for a few days to sample the spectrum of pressures. They are proceeding with this testing at succeeding increased pressures. Up to that time, they were testing an equivalent pressure of 50 MPH wind. No leaks were observed. We asked them to continue increasing the rate of wind spray to the maximum, to check for water leaks, where they might occur and where they travel to. This test should be completed in a few weeks. They said that they will make available to us all the test data which has been performed on the WTC wall sample.

Generally in the New York City area, metal and glass curtain walls have been and are presently designed to resist failure by water and air infiltration at about a 65 MPH wind or rain storm or an equivalent of 10 PSF of projected area. The WTC tower design has higher specific requirements that must be met. The determination of the suitability of the WTC wall and window design cannot be a matter of vendor judgement but rather a rigorous technical approach to overcome objectionable external conditions. Rather than the usual approach to the design of curtain walls by factors of probability of rain and gusts, duration, building location and shape factor, ERS will provide the wall manufacturer with specific criteria derived from the WTC wind study program. Another factor in the design of the exterior wall must be the assurance that when the wall and its integrated elements are erected, that there will be minimal erection errors that could cause water and air infiltration.

One of the elements to be considered in the design of the wall is the method and material application of the exterior columns and spandrel fireproofing. Several methods and applications have been studied with relation to the present profile. One of the methods is applying a spray-on fireproofing from the outside face of the tower. We are seeking to devise a method to avoid the exterior approach. Republic Steel Company has been asked to try two applications; one by pre-applying the fireproofing to the column prior to erection of the column covers and spandrel and the other is to pump a fireproofing material in the void between the installed column cover and the exterior box column. In the latter application in the demonstration mock-up, a lightweight concrete "Zonolite" fill material was used on one column. This was tried for two reasons; one, for ease of installation and, two, to provide a solid fill in the column skin profile, to avoid water drainage, seepage and eliminate the "tincanning" of the metal column covers. The test installation showed that the column cover can bulge in spots. This can be overcome by ribbing the metal to make it stiffer and overcome the hydrostatic pressure. The other column fireproofing installation did not appear suitable for a spray-on from the outside of a high rise building, because of the installation requirements.

We are considering another approach to the column fireproofing and that is by pre-applying a fireproofing spray to the inside of the exterior face of the column jacket (adjacent to the window washing track), then erecting the column cover and spraying the remaining sides of the void between cover and box column from the inside of the building. This technique must be examined from the cost of handling, damage to the paper protected exterior metal, and the touch-up required for fireproofing broken off in handling.

There is no doubt that Republic Steel Company has spent considerable time and money on the development of their proposal, as evidenced by their detail drawings, wall mock-up and physical testing program.

All observers were very impressed with the preparation and exhibit of the wall mock-up and the scientific approach of the environmental testing.

The aesthetics of the exterior wall appeared to be satisfactory as viewed by our staff and the design consultants present. However, Mr. Gershon of ERS felt that the design of the jointing details by Republic had some shortcomings. He will review these details with Republic. These joints must be considered with great care in order to avoid air and water leaks between the column covers, spandrel covers, window washing track and the glazing. We will report periodically on the progress of the exterior wall development.

Irving L. Soffer
Planning & Construction Division
The World Trade Center

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